K-5 Science: Bridging the Gap Between the Vision of *A Framework for K-12 Science Education* and Arizona's Science Standard

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Overview for Today

Provide information about

- *A Framework for K-12 Science Education*
- Current research on science education
- K-5 Learning Progressions
- Gap analysis documents for modifying K-5 Science Instruction

Vision of K-12 Science Education

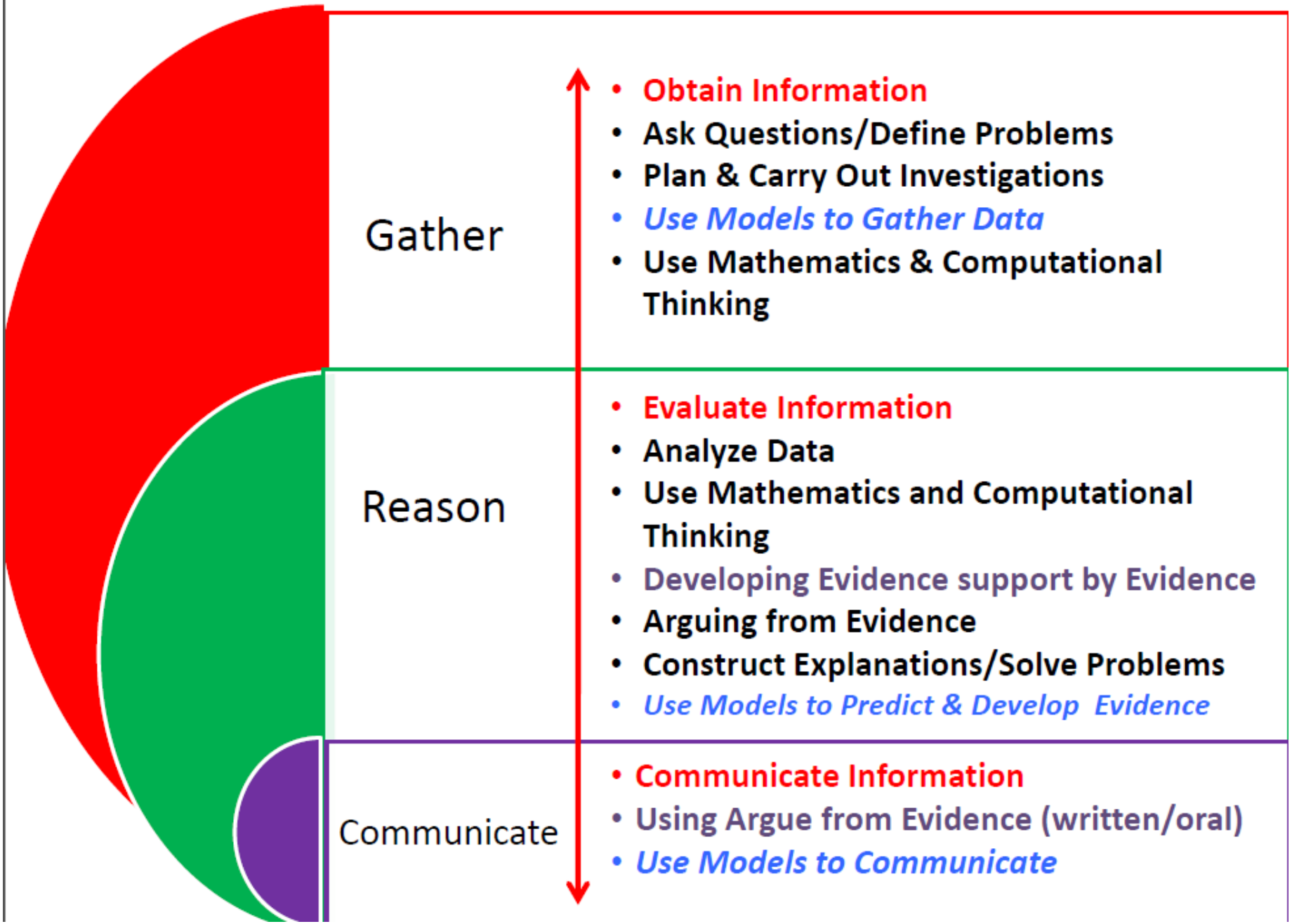
Outcomes for Science Instruction

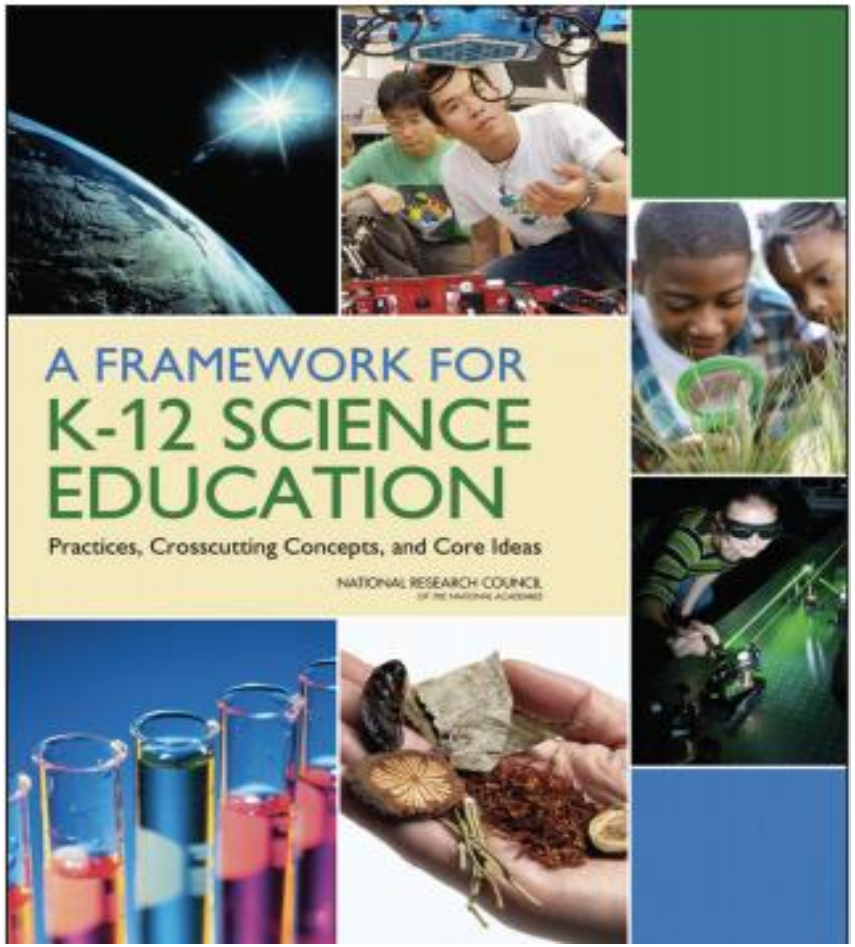
All students will:

Value and use science as a process of obtaining knowledge based upon observable evidence.

Engaging students in developing the knowledge and skills to:

1. Gather – Obtain and evaluate information
2. Reason – Construct explanations of phenomena and use evidence to develop arguments
3. Communicate – Communicate explanations using evidence and Core ideas to support scientific arguments


Gather
Obtain Information
Ask Questions/Define Problems
Plan & Carry Out Investigations
Use Models to Gather Data
Use Mathematics & Computational Thinking
Reason
Evaluate Information
Analyze Data
Use Mathematics and Computational Thinking
Developing Evidence support by Evidence
Arguing from Evidence
Construct Explanations/Solve Problems
Use Models to Predict & Develop Evidence
Communicate
Communicate Information
Using Argue from Evidence (written/oral)
Use Models to Communicate



National Academies of Science publication, *A Framework for K-12 Science Education*, outlines a new vision for science learning and teaching.

Download the Framework for K-12 Science Education
http://www.nap.edu/catalog.php?record_id=13165

Conceptual Shifts

1. K-12 Science Education Should Reflect the Interconnected Nature of Science as it is **Practiced and Experienced in the Real World**.
2. Science concepts build coherently from K-12.
3. Focus on deeper understanding of content as well as application of content.

Scientific and Engineering Practices

1. Asking questions and defining problems (pp. 54-56)
2. Developing and using models (pp. 56-59)
3. Planning and carrying out investigations (pp. 59-61)
4. Analyzing and interpreting data (pp. 61-63)
5. Using mathematics and computational thinking (pp. 64-66)
6. Developing explanations and designing solutions (pp.67-71)
7. Engaging in argument from evidence (pp.71-74)
8. Obtaining, evaluating, and communicating information (pp. 74- 77)

Connect to ACCS Mathematics
Connect to ACCS ELA

Crosscutting Concepts

- Patterns, similarity, and diversity (pp.85-86)
- Cause and effect (pp. 87-89)
- Scale, proportion and quantity (pp.89-91)
- Systems and system model (pp. 91-94)
- Energy and matter (pp. 94-96)
- Structure and function (pp.96-98)
- Stability and change (pp.98-101)

Provides conceptual framework to connect understandings into a coherent and scientifically-based view of the world

Disciplinary Core Ideas (DCIs)

Focus on the most important aspects of science content across four domains:

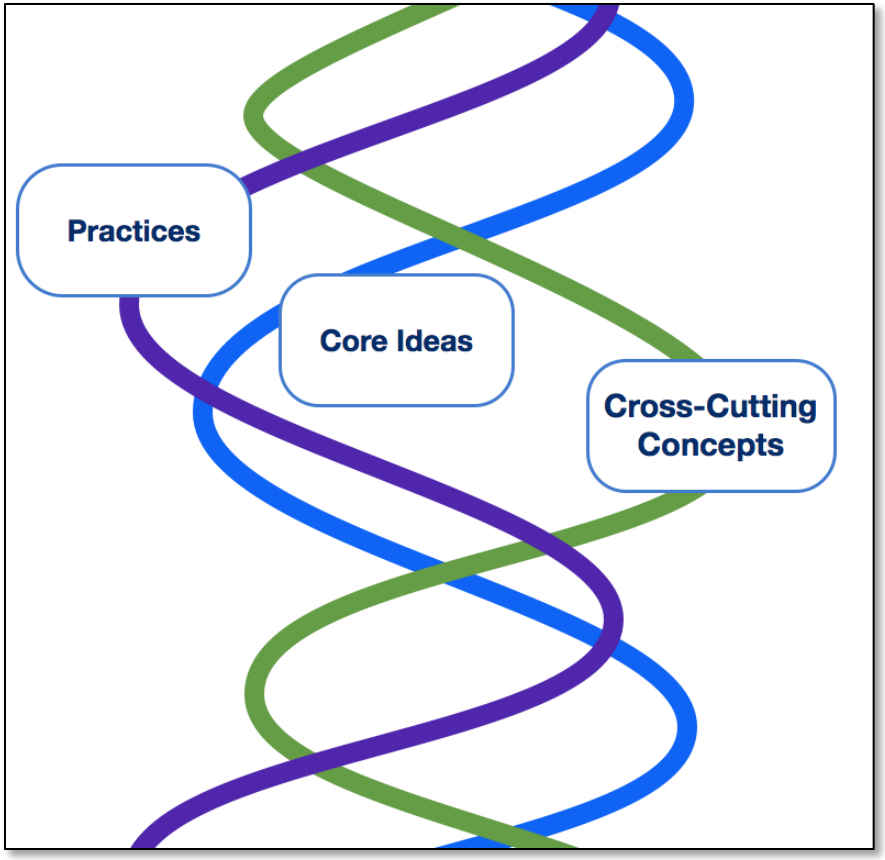
- physical sciences
- life sciences
- Earth and space sciences
- engineering, technology and applications of science

Disciplinary Core Ideas

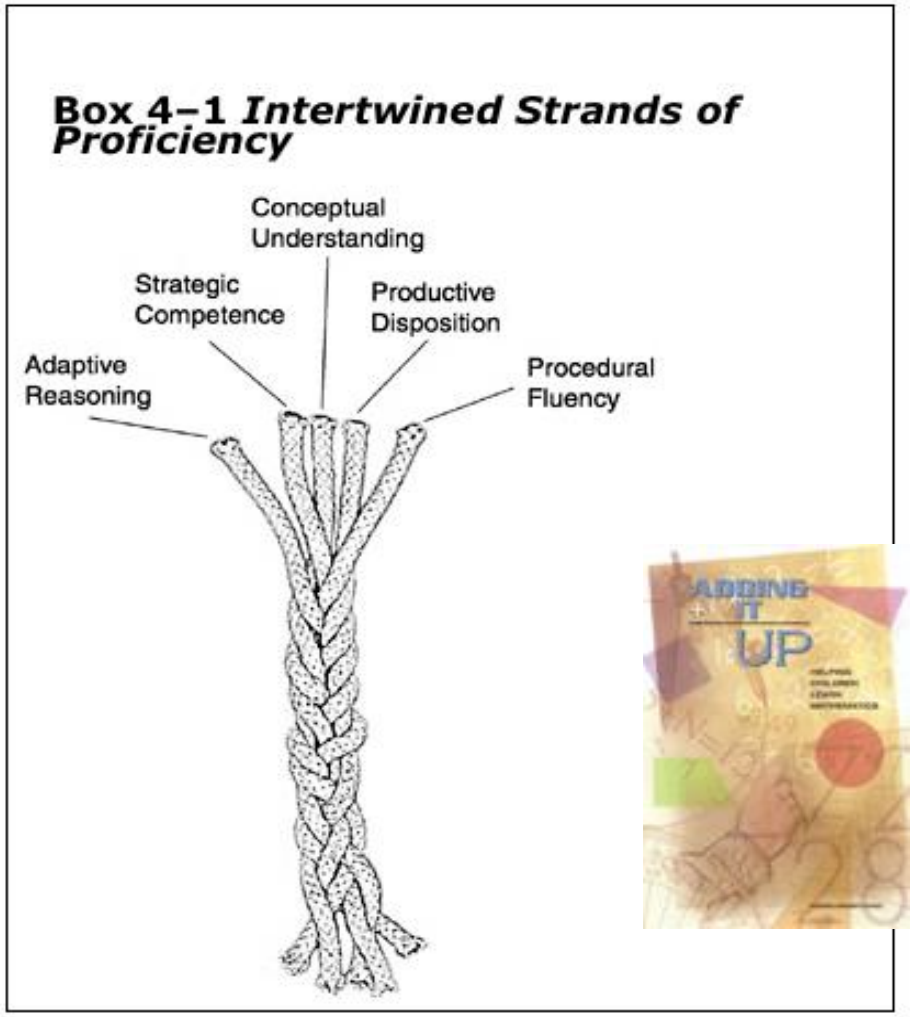
Must meet at least two of the four criteria:

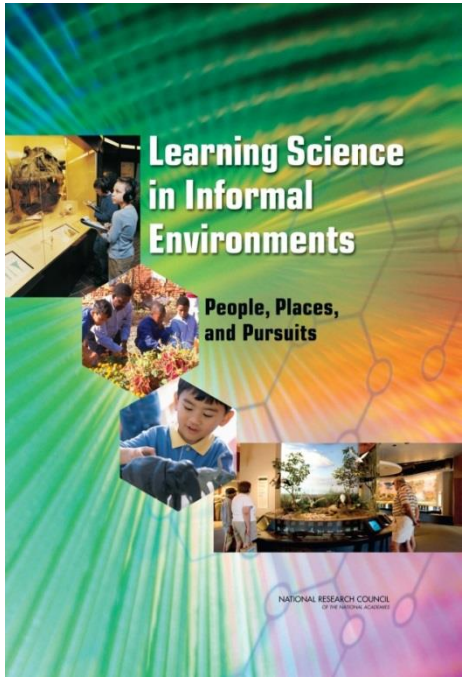
- broad importance across multiple disciplines or a key organizing concept of a single discipline
- key tool for understanding/investigating more complex ideas and solving problems
- connect to societal or personal concerns/interests that require scientific or technological knowledge
- teachable/learnable over multiple grades at increasing levels of depth and sophistication (learning progressions)

Three Dimensions Intertwined

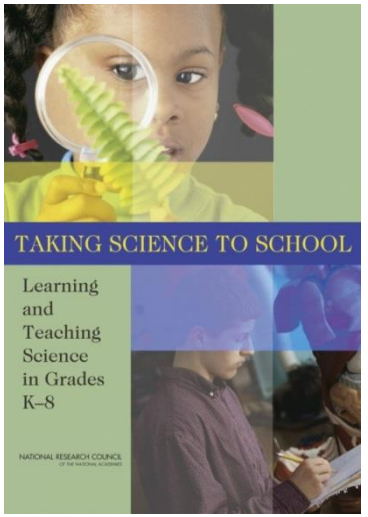


How do we know this approach works?





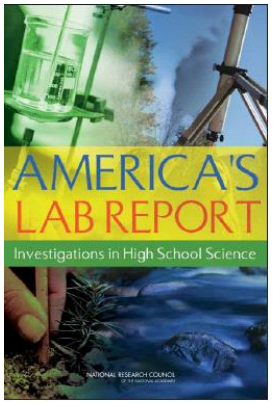
6 strands – incorporates affective domain



4 strands

Motivation and Engagement

Goals of Laboratory Experiences based on ALR Findings



- Mastery of subject matter.
- Developing scientific reasoning.
- Understanding the complexity and ambiguity of empirical work.
- Developing practical skills.
- Interest in science and science learning.

Currently, research indicates significant numbers of students do not have quality opportunities to engage in science and engineering practices

Findings from ALR

Typical Lab Practice

- Content Mastery
  - No better or worse than other modes of instruction.
- Scientific Reasoning
  - Aids development of *some* aspects
- Interest in Science
  - *Some* evidence of increased interest.

Integrated Dimensions

- Content Mastery
  - Increased mastery of subject matter compared to other modes of instruction.
- Scientific Reasoning
  - Aids development of *more sophisticated* aspects
- Interest in Science
  - *Strong* evidence of increased interest.

Science and Engineering Practices, Not just teaching strategies

- Science and Engineering Practices are how scientific knowledge is acquired
- While Practices should be used in instruction, all students need to demonstrate achievement in their use and application

Promoting Equity

Researchers have documented that children reared in rural agricultural communities, who experience intense and regular interactions with plants and animals, develop more sophisticated understanding of ecology and biological species than do urban and suburban children of the same age. (Framework, page 28)

Children Are Born Investigators

- The capacity of young children to reason in sophisticated ways is much greater than has long been assumed
- Children's early intuitions about the world can be used as a foundation to build remarkable understanding, even in the earliest grades

Building progressively more sophisticated explanations of natural phenomena is central throughout K-5, as opposed to focusing only on description in the early grades and leaving explanation to the later grades. (Framework page 24)

Progressing to Understanding

	K-2	3-5	6-8	9-12
PS1.A Structure of matter	Objects can be built up from smaller parts. Matter exists as different substances that have observable different properties. Different properties are suited to different purposes.	Because matter exists as particles that are too small to see, matter is always conserved even if it seems to disappear, Measurements of a variety of observable properties can be used to identify particular substances.	The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.	The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain the structure and interactions of matter, including chemical reactions. Repeating patterns of the periodic table reflect patterns of outer electrons. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

K-5 Learning Progression Tour

A Framework for K-12 Science Education has identified learning progressions for each disciplinary core idea.

Physical science Learning Progressions 106-137

Life Science Learning Progressions 143 - 167

Earth and Space Learning Progressions 173-198

Bundling, its what for understanding

- Teaching, or attempting to teach, individual performance expectations lead to a disjointed and stunted view of science.
- Developing instructional materials and instruction should be viewed as leading to understanding the larger core idea
- Coherent instructional materials and instruction should focus on a Disciplinary Core Idea (or set of them) rather than discrete pieces that are never tied together.

Curriculum Analysis

Several Documents are finished for your use and can be found on the Science Resource Page

http://www.azed.gov/standards-practices/academic-standards/science/

Guidelines for developing K-5 Science Curriculum Analysis Worksheet

Current research on science education emphasizes the importance of integrating the learning progressions from all three dimensions included in *A Framework for K-12 Science Education.* This Curriculum Analysis Worksheet is a tool that can be used to change your current instructional practices and deepen student learning.

1.	Identify a science concept or concepts within Arizona's Science standard from Strands 4, 5 or 6. Fill in the title of the science concept at the top of the worksheet.
2.	Identify the conceptual understandings within Strands1-3 (Practices and Crosscutting concepts) and Strands 4-6 (Content Learning Progressions).
3.	a. Identify the current objectives from the Arizona Science Standard from Strands 1, 2 and 3 that align with the learning progressions you have identified from the Learning Progressions for K-5 document. b. Examine your current science curriculum to identify ways you can start to reach the vision of *A Framework for K-12 Science Education* while you currently teach objectives from your grade level Arizona Science Standards.
4.	a. Identify the current objectives from the Arizona Science Standard from Strands 4, 5, and 6 that align with the learning progressions you have identified from the Learning Progressions for K-5 document. b. Examine your current science curriculum to identify ways you can start to reach the vision of *A Framework for K-12 Science Education* while you currently teach your grade level objectives from the Arizona Science Standard.
5.	a. Identify the current Arizona Science standard crosscutting concept or concepts that align with the learning progressions you have identified from the Learning Progressions for K-5 document. b. Examine your current science curriculum to identify ways you can start to reach the vision of *A Framework for K-12 Science Education* while you currently teach your grade level objectives from the Arizona Science Standard.

Thank You!

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